

(c) Under the conditions specified in (b) the third and fourth lines are quickly calculated by the table in § 13.

(d) If, further, the trails be of the same star, we need *only the fourth line*, as given by the little table of § 10.

(e) If we neglect quantities less than $1''.0$, then the curvatures of all trails on a plate exposed near the meridian between $D=0^\circ$ and $D=45^\circ$ should be the same, unless there is optical distortion.

Remarks on the Paper by Professor W. Schur, together with determination of the Diameter and Polar Compression of the Planet Mars from Observations with the Repsold Heliumeter of the Remeis Observatory, Bamberg, and with the Breslau Heliumeter at the Observatory, Strassburg, in 1879. By Dr. Ernst Hartwig.

(Communicated by the Secretaries.)

In the March number of the *Monthly Notices* (p. 330) Professor Schur has communicated a series of heliometer measurements of the polar and equatorial diameters of the planet *Mars*, from which he deduces a polar compression of a fiftieth. In that discussion no reference is made to the probable errors of the results which are said to be of a greater weight than the earlier researches because an ocular reversing prism was used. Computing the mean errors for the single measures and for the results of one day I have found them (in spite of "images being steady") greater than they were in the measurements made by the same observer with the little Breslau heliometer at Strassburg in 1877. The mean error of a diameter reduced to mean distance of the planet *Mars* from the Sun is for the polar diameter $\pm 0''.112$, for the equatorial $\pm 0''.094$ (in mean distance Sun—Earth $\pm 0''.170$ and $\pm 0''.143$), therefore for the measured diameter $\pm 0''.23$ and $\pm 0''.19$, or for a distance of *Mars* the same as in 1877 $\pm 0''.454$ and $\pm 0''.378$, the corresponding mean errors in 1877 having been for the measures made by Dr. Schur with the Breslau heliometer $\pm 0''.208$ and $\pm 0''.207$.

The three days of 1899 give a mean difference of $0''.170$ between both directions (polar and equatorial) for the diameter in the mean distance between Sun and Earth, and the mean error of it is $\pm 0''.128$, because the single difference has the mean error $\pm 0''.222$. The measures in 1896 are better, the mean error for the result of a day being (polar diameter) $\pm 0''.031$ and (equatorial diameter) $\pm 0''.064$ in mean distance of the Earth from the Sun, whence we find for the single difference the mean error $\pm 0''.071$, and for the mean, $0''.205$, of the four differences the mean error $\pm 0''.036$. But the measures in 1899 in view of the great uncertainty do not prove that the compression is in conflict with

that which Hermann Struve has calculated from his researches on the motions of the apsides of the satellites *Phobos* and *Deimos*; and the measures in 1896 disagree with those in 1899 made by myself, which are independent of errors in estimation. I have also measured the diameter of *Mars* with the great Repsold heliometer of the Remeis Observatory since 1890, using the ocular reversing prism to eliminate the personal errors in measuring diameters of discs in different directions with respect to the vertical line. The bad conditions of atmosphere have prevented my getting more than one opportunity for measuring in both directions in each opposition 1890 and 1899. The measures, all made with apparent vertical motion of the images by means of the ocular reversing prism and corrected for defect of illumination, which I have directly computed in Bessel's manner, are the following:—

Date, 1890 (8 May 27).	Mean Time, Bamberg.	Position-Angle.		Measured Diameter.	Diameter at Mean Distance Sun—Earth.
	h m	Observed.	Computed.		
May 6	12 46	54°2	36°3	16"522	9"222
	13 0	144°2	126°3	16"904	9"435
	13 14	144°2	126°3	16"828	9"393
	13 29	54°2	36°3	16"773	9"362
¹⁸⁹⁴ (8 Oct. 20).					
July 24	14 57	156°8	126°8	12"757	9"338
Aug. 26	16 52	156°9	129°9	16"351	9"196*
Sept. 14	13 55	156°3	130°2	19"437	9"424
¹⁸⁹⁹ (8 Jan. 18).					
Feb. 4	9 48	350°9	345°3	13"356	9"278
	10 2	260°9	255°3	13"447	9"340
	10 15	260°9	255°3	13"533	9"401
	10 37	350°9	345°3	13"333	9"262
Feb. 21	10 42	345°2	343°3	11"629	9"205†

whence we have

	Polar Diameter.	Equatorial.	$a-b$	$\frac{a-b}{a}$
1890	9"292	9"414	0"122	$\frac{1}{77}$
1899	9"270	9"370	0"100	$\frac{1}{94}$

Neglecting the deviation in areographic latitude‡ the mean of the differences is 0"·111. The mean error of a measure for the polar diameter from observations 1890, 1894, and 1899 is $\pm 0"·068$, and if we assume the same mean error for the equatorial diameter, we get for the mean error of a single difference $\pm 0"·096$ and

* In daylight.

† Only measured for position-angle.

‡ The areographic latitude 90°, in the paper of Professor Schur, is not right, because the middle of the disc of *Mars* was 13°·6 north of its equator at opposition, January 18.

of the mean of the two differences $\pm 0''.068$, essentially less than the value of the difference itself; therefore a polar compression seems to exist and not to be in too great discordance with the theoretical value. In the *Ast. Nach.* 2272 I drew attention to the extremely good opportunity afforded by the opposition of 1879 for measuring the polar and equatorial diameter of *Mars*, each in both vertical and horizontal directions at eastern and western hour-angles. I have made a large series of measurements with the Breslau heliometer at Strassburg, the results of which will appear shortly in the *Astron. Nachrichten*. Herewith I have the honour to communicate the results of measurements of both diameters, obtained near the opposition of 1879. By v and h are denoted vertical and horizontal direction of the rotation axis, and by \times an inclination of nearly 45° , when *Mars* was passing the meridian.

Date, 1879.	Mean Time, Greenwich.	Rotation Axis.	Diameter—		Diameter at Mean	
			Polar.	Equatorial.	Distance, Sun—Earth. Polar.	Equatorial.
Oct. 5	^h 10.8	v	17.137	17.280	9.394	9.473
	16.0	h	17.015	17.501	313	579
	7	v	17.351	17.412	376	411
	13	v	18.047	18.098	378	405
	24	v	18.940	19.170	322	435
Nov. 7	11.8	\times	19.319	19.513	338	432
	8	h	19.487	19.673	434	524
	9	v	19.290	19.553	355	482
	14	\times	19.124	19.319	411	507
	27	v	17.830	17.791	476	457
		\times	17.598	17.773	365	457
	28	v	17.400	17.690	323	479
		\times	17.208	17.641	230	462
		h	17.266	17.487	270	388
	29	\times	17.102	17.396	253	412
		h	17.360	17.126	401	275
Dec. 2	13.7	h	16.865	16.872	374	376
	7	v	16.072	16.299	342	472
				Mean	9.353	9.446
Mean error					± 0.015	± 0.016

The measures reduplicated on the same day are made in different positions of the disc relative to the eye of the observer, and may be considered as independent. No systematic discordance occurs between the measurements in the two (or three) directions of the two diameters with the vertical line. For we have

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Polar Diameter.			Equatorial Diameter.		
v	h	x	v	h	x
9''·394	9''·313	9''·338	9''·579	9''·473	9''·432
·376	·434	·411	·524	·411	·507
·378	·270	·365	·388	·405	·457
·322	·401	·230	·275	·435	·462
·355	·374	·253	·376	·482	·412
·476				·457	
·323				·479	
·342				·472	
9''·371	9''·358	9''·319	9''·428	9''·452	9''·454
$v-h = +0''·013$			$v-h = -0''·024$		

in both cases the difference between vertical and horizontal direction being smaller than the probable error of it.

The differences "equatorial minus polar" for the three directions are

$2a-2b$	$\frac{a-b}{a}$
$v + 0''·057$	1 : 166
$h + 0''·094$	1 : 101
$x + 0''·135$	1 : 70

Hence the figure of the planet, when the axis of rotation is inclined at 45° to the vertical line, seems to the observer to be different from that in the other positions. But the result depends chiefly upon the two measures of the polar diameter made on November 28 and 29, which are the smallest of the whole series. I believe the mean of all the measures to be free from personal errors arising from difference in the position of the rotation axis in regard to the vertical line. Hence we have the difference between the polar and equatorial diameters in mean distance of the Earth from the Sun $= 0''·093$ with the mean error $\pm 0''·021$, and the polar compression $= \frac{1}{102}$, agreeing well with the result obtained with the great Repsold heliometer of the Remeis Observatory, $0''·111$, i.e. $\frac{1}{85}$. The mean of the measurements of the polar diameter with the latter heliometer on four days, viz. $9''·331$ (mean error $\pm 0''·034$), is also in agreement with the result above, $9''·353$ (mean error $\pm 0''·015$). The higher power of the Bamberg heliometer just compensates in these measures for the greater apparent diameter of the disc as measured with the Breslau heliometer in the opposition of 1879. The value $0''·1$ for the difference between the polar and equatorial diameter of *Mars* in mean distance of Earth from Sun is doubtless not far from the truth.

1899 May.

Observations of Mars made at Mr. Crossley's Observatory, Bermer-side, Halifax, during the Opposition 1898-9. By J. Gledhill.

I.

Notes on the Markings Seen on the Disc.

The following observations of *Mars* were made with the 9-inch Cooke Equatorial Refractor (the new triple object glass). The powers used were 240 and 330; the former as that most generally useful, the latter on the very few exceptionally good nights. The planet was carefully examined—indeed, watched almost continuously, often for several hours—on every clear night from 1898 December 19 to the end of March 1899, in all some forty nights. The definition was never continuously good, and the seeing and identification of the features often called for much patient gazing. The limb and the terminator were on every occasion most carefully examined for irregularities of form. No such were ever surely seen except on one night, the one occasion when the perfect stillness of the planet allowed of the use of powers 330 and 470. The southern edge of the N. polar ice-cap was often examined, but no trace of any breaks or projections was ever seen. To a very large extent, no doubt, these failures were simply a measure of the bad observing conditions experienced here during the winter. The projection seen for more than an hour on 1899 January 24 would certainly have escaped detection on an average night owing to the undulations on the limb.

1898 December 19, 11^h to 12^h, λ , the longitude of the central meridian, = 295° to 310°. Bad definition, p limb very bright, the bright lune extending inwards up to the Kaiser Sea; f limb dull; the N. polar ice-cap large and white. The dusky Delambre Sea extends from the S. edge of the ice-cap nearly to the N. point of the Kaiser Sea. All the region to the east of the Kaiser Sea (between it and the f limb) was of a warm tinge.

1898 December 20, 11^h to 12^h, λ = 286° to 301°. There was a bright region about the S. pole of the disc—probably Lockyer Land. It was bright and of a pale yellow tint. As always, the N. portion of the Kaiser Sea was the darkest portion of that feature, and also perhaps one of the darkest parts of the disc. There was a little warm colour in the region p , the Kaiser Sea (Herschel I. Continent), and a deeper tint in the region following it (Beer Continent). The bright lune at p limb was much narrower than on the 19th. Delambre Sea was seen, but not well.

1898 December 22, 11^h, λ = 268°. Lockyer Land, the Kaiser Sea, the grey space between the two, Delambre Sea and the coloured continents of Herschel I. and Beer, were seen as on the 20th.